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# Sowing depth and seed specific weights on emergence of the weed *Urochloa ruziziensis* on field conditions

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**ABSTRACT:** The objective of this study was to evaluate the effects of sowing depths and specific seed weights on the emergence of *Urochloa ruziziensis* in the field. A randomized block experimental design was adopted, with four replications and the treatments distributed in a 6 × 3 factorial scheme, with six sowing depths (1.0, 2.0, 4.0, 8.0, 12.0, and 16.0 cm) associated with three specific seed weights (low, medium, and high). The effects of the treatments were evaluated using seedling emergence tests in the field. The different specific seed weights did not reduce the emergence of *U. ruziziensis* seedlings in the field. The seedlings of the weed *U. ruziziensis* emerged at depths of up to 12 cm. Sowings between 1.0 and 4.0 cm deep gave the highest values for the percentage and speed of emergence and the shortest average time for *U. ruziziensis* seedlings to emerge in the field. The relative frequency polygons show that depths greater than 2.0 cm slow down the propagation of *U. ruziziensis*, regardless of the specific weight of the seeds.

**Key words:** germination; seed physiological quality; specific mass; vertical arrangement; weeds

# Profundidade de semeadura e peso específico das sementes na emergência da planta daninha *Urochloa ruziziensis* em campo

**RESUMO:** O objetivo desse estudo foi avaliar, em campo, os efeitos de profundidades de semeadura e de pesos específicos das sementes sob a emergência da espécie *Urochloa ruziziensis*. Adotou-se o delineamento experimental em blocos casualizados, com quatro repetições e os tratamentos distribuídos em esquema fatorial 6 × 3, sendo seis profundidades de semeadura (1,0; 2,0; 4,0; 8,0; 12,0 e 16,0 cm) associados a três pesos específicos de sementes (baixo, médio e alto). Os efeitos dos tratamentos foram avaliados por meio de testes de emergência de plântulas em campo. Os diferentes pesos específicos de sementes não reduziram a emergência de plântulas de *U. ruziziensis* em campo. As plântulas da planta daninha *U. ruziziensis* emergiram em profundidades de até 12 cm. Semeaduras entre 1,0 e 4,0 cm de profundidade promoveram os maiores valores de porcentagem e índice de velocidade de emergência e, o menor tempo médio para a emergência de plântulas de *U. ruziziensis* em campo. Os polígonos de frequência relativa revelam que profundidades superiores a 2,0 cm induzem ao retardo na propagação do *U. ruziziensis*, independente do peso específico das sementes.

**Palavras-chave:** germinação; qualidade fisiológica de sementes; massa das sementes; disposição vertical; plantas daninhas

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## Introduction

Weeds are one of the ecological factors that most affect the agricultural economy on a permanent basis, because in addition to causing physiological damage to crops, their control also entails expenses that increase the cost of production (Monquero et al., 2015; Santos et al., 2019). It should be noted that many of the problematic grass weed species currently found in Brazil were voluntarily introduced by man for economic purposes, mainly for fodder (Silva Junior et al., 2023).

Weed species, such as those of the *Urochloa* genus, compete with agricultural crops for physical space and environmental resources, can be hosts to pests and diseases, interfere with the harvesting process, increase the formation and recovery time of other forage grasses and can also decrease the acceptability of animals, making it necessary to use alternative methods to manage these weeds in the field (Lourenço et al., 2019; Marchi et al., 2020).

Seed germination is regulated by the interaction of environmental conditions with their state of physiological fitness, with each plant species requiring a set of environmental resources necessary for the germination of its seeds, such as: the availability of water, light, temperature and the depth at which they are found in the soil profile (Zuffo et al., 2014). Thus, knowledge of the emergence capacity of seedlings from seeds located at different depths in the soil can help in weed management, by adopting methods that reduce or prevent their occurrence (Orzari et al., 2013).

It is known that the vast majority of weeds reproduce by seed and the success of this is due to the ability to distribute germination over time (dormancy and longevity in the soil) and space (dispersal) (Grime, 2006). However, these species that propagate seminiferously have evolved to produce more seeds, to the detriment of their specific weight, thus creating mechanisms to accelerate the germination process at suitable depths, since the reduced availability of seed reserves would not be sufficient to support the growth of the seedling until emergence (Souza et al., 2021).

The quantity and specific weight of seeds can also be influenced by environmental conditions. Thus, for the same weed species, it is possible to produce seeds with different specific weights (Carvalho & Nakagawa, 2012). The quality of these seeds is determined by chemical, physical, health and physiological attributes, since the processes of germination and initial seedling development are directly linked to these attributes (Marques et al., 2023).

It should be noted that studies on the influence of specific seed weight and sowing depth on the emergence of weeds in field conditions are scarce, but necessary, due to the great importance of the species and the limited information related to the production of seeds from these plants. This understanding is useful for modeling the potential invasion of weed species, as well as providing subsidies for the development and adoption of relevant management practices, reducing or preventing the appearance of undesirable species in agricultural areas.

The objective of this study was to evaluate, under field conditions, the effects of different specific seed weights and sowing depths on the emergence of congo grass [*Urochloa ruziziensis* (R. Germ. & Evrard) Crins].

## Materials and Methods

The field trial phase of this research was represented by studies conducted over two years and in two different locations.

The first study was conducted in 2021, in an experimental area belonging to the Departamento de Produção Vegetal, Faculdade de Ciências Agrárias e Veterinárias, UNESP, in the municipality of Jaboticabal - SP, Brazil, whose geographical coordinates are: 21° 14’ 43.42” S and 48° 17’ 32.80” W, with an altitude of 583 m. The second study was conducted in 2022, in an area located in the experimental field of the Universidade Federal de Mato Grosso - Campus Universitário do Araguaia, located in the municipality of Barra do Garças - MT, Brazil, whose geographical coordinates are: 15° 52’ 25” S and 52° 18’ 51” W, with an altitude of 318 m.

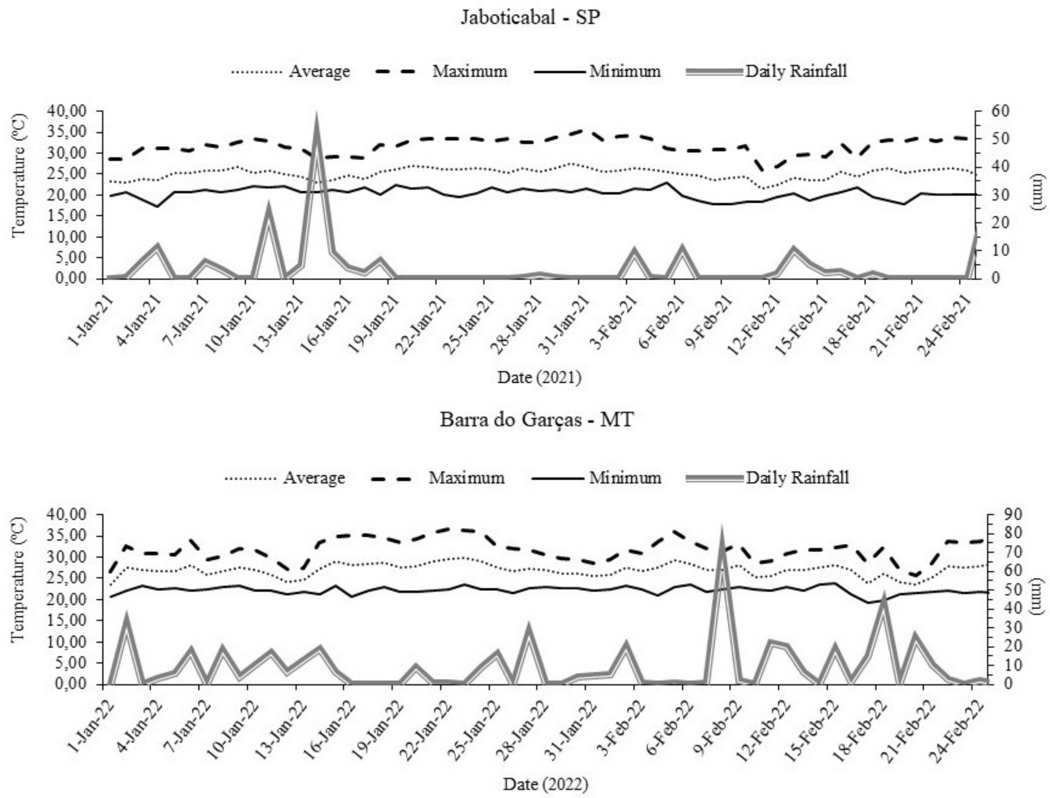
The climate of Jaboticabal - SP, Brazil, according to the Köppen system, is classified as Cwa (subtropical mesothermal with dry winter), with average rainfall between 1,100 and 1,700 mm per year and average temperatures of 22 °C in the hottest month and 18 °C in the coldest month. The climate of Barra do Garças - MT, Brazil, is of the Aw type (tropical with dry winter), characterized by average temperatures above 27 °C in the hottest months, average temperatures above 18 °C in the coldest months and average annual rainfall between 1,000 and 1,500 mm. The climatological data observed during the period in which the experiments were conducted, in both regions and years, is shown in Figure 1.

The experimental design was randomized blocks, with four replications and the treatments distributed in a 6 × 3 factorial scheme, with six sowing depths (1.0, 2.0, 4.0, 8.0, 12.0, and 16.0 cm deep) associated with three specific seed weights, considered low, medium, and high.

Preparation of the areas began 15 days before sowing, with desiccation for total control of the existing vegetation, using the herbicide glyphosate at a dose of 1,080 g e.a $ha^{-1}$, with subsequent plowing with a disc plow, ending with two harrowings: one heavy and the other leveling, for total incorporation of the plant remains.

Composite soil samples from both years were collected and sent for laboratory analysis and their chemical and physical characteristics are shown in Tables 1 and 2.

The seeds were purchased from a reputable company. In order to obtain seeds of different specific weights, five lots from different stages of seed processing were chosen. To do this, the seeds were sampled by taking composite samples from batches known as: “Sementes Brutas”, “Sementes Limpas”, “Torrão”, “Palha”, and “Mesa I Intermediária”, obtained from different discharge spouts of the air and sieve machines, gravitational tables and seed treatment machine,




Source: 2021 (Agrometeorological station - UNESP, 2023) - 2022 (INMET, 2023).

**Figure 1.** Minimum, maximum and average temperatures and daily rainfall observed in the regions of Jaboticabal - SP and Barra do Garças - MT during the periods in which the experiments were conducted.

**Table 1.** Chemical and granulometric analysis of the soil in Jaboticabal - SP, 2021.

| pH $CaCl_2$ (0.01 mol $L^{-1}$) | OM (g $dm^{-3}$) | $P_{resine}$ (mg $dm^{-3}$) | K | Ca | Mg | H+Al | S | CEC | V (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | (mmol$_c$ $dm^{-3}$) | | | | | | |
| 5.0 | 15.0 | 20.0 | 2.1 | 17.0 | 5.0 | 22.0 | 0.1 | 46.6 | 53 |

| Granulometric composition (g $kg^{-1}$) | | | | |
|---|---|---|---|---|
| Clay | Silt | Coarse sand | Fine sand | Total sand |
| 250 | 40 | 300 | 410 | 710 |
| Textural class: Franco Argilo-Arenosa | | | | |

OM - Organic matter. CEC - Cation exchange capacity. V% - Base saturation.

**Table 2.** Chemical and granulometric analysis of the soil in Barra do Garças - MT, 2022.

| pH $CaCl_2$ (0.01 mol $L^{-1}$) | OM (g $dm^{-3}$) | $P_{resine}$ (mg $dm^{-3}$) | K | Ca | Mg | H+Al | S | CEC | V (%) |
|---|---|---|---|---|---|---|---|---|---|
| | | | (mmol$_c$ $dm^{-3}$) | | | | | | |
| 4.0 | 22.9 | 3.8 | 1.0 | 6.6 | 4.2 | 40.0 | -- | 27.1 | 23.5 |

| Granulometric composition (g $kg^{1}$) | | | | |
|---|---|---|---|---|
| Clay | Silt | Coarse sand | Fine sand | Total sand |
| 350 | 75 | 200 | 375 | 575 |
| Textural class: Clay - Sandy | | | | |

OM - Organic matter. CEC - Cation exchange capacity. V% - Base saturation.

which allowed separation by specific weight (Brasil, 2009; Melo et al., 2016).

The batches were received at the Laboratório de Análise de Sementes/Departamento de Produção Vegetal/ Faculdade de Ciências Agrárias e Veterinárias (UNESP), Jaboticabal Campus - SP, where they were cleaned using a General Seed Blower, set at a specific opening for the species for 120 seconds, to remove any empty spikelets and plant debris. The plots called “Torrão” and “Mesa I Intermediária” were also cleaned manually using tweezers to separate soil fragments.

In order to choose the lots that characterized the seeds of different specific weights, the weights of a thousand seeds were determined by weighing eight 100-seed subsamples on a scale with a precision of 0.001g, with the results expressed in grams (Brasil, 2009) (Table 3).

Preliminary germination tests were carried out with four subsamples of 100 seeds, sown on two sheets of filter paper

**Table 3.** Thousand-seed weight of seed lots with different specific weights.

| Specie | Specific seed weight (g) | | |
|---|---|---|---|
| | Low | Medium | High |
| *U. ruziziensis* | 6.53 | 7.32 | 7.97 |

moistened with twice the weight of the paper in $KNO_3$ (0.2%), in GERBOX-type plastic boxes (11.0 × 11.0 × 3.5 cm), at an alternating temperature of 15-35 °C and an eight-hour light period (Brasil, 2009). In this way, it was possible to obtain the germination percentage, which was used to calculate the quantity of seeds from each lot needed for at least 50 seedlings to emerge in the field experiments.

The experimental plots were 1.0 m wide by 5.0 m long, with a standardized useful area in the center of the plots, with 25 cm deducted at each end. A distance of 10 cm was established between the sowing furrows at different depths. Each experimental plot consisted of a specific weight of seeds, randomized in the experimental units before sowing.

Sowing was carried out by hand in damp soil and the sowing depths were obtained using a wooden frame, 20 cm wide and 2 cm thick, with the exact measurements for each depth (Figure 2). In this way, the seeding depth was kept uniform along the entire length of the furrow. Sowing was carried out following the same pattern of depths, from the lowest to the highest, to better visualize and evaluate the plants in the field.

Irrigations were carried out manually, four times a week, with an average distribution calculated to obtain approximately 10 mm of water for each irrigation, taking into account the average accumulated rainfall during the period.

The number of emerged seedlings was counted daily until the date on which there was no variation between evaluations for at least five consecutive days. The seedling was counted when it emerged and the first eophilus was fully exposed.

The effects of the treatments were calculated to obtain the percentage of emergence (%E), emergence speed index (ESI), average emergency time (AET), synchrony (Z), and relative frequency (Fr) of seedling.

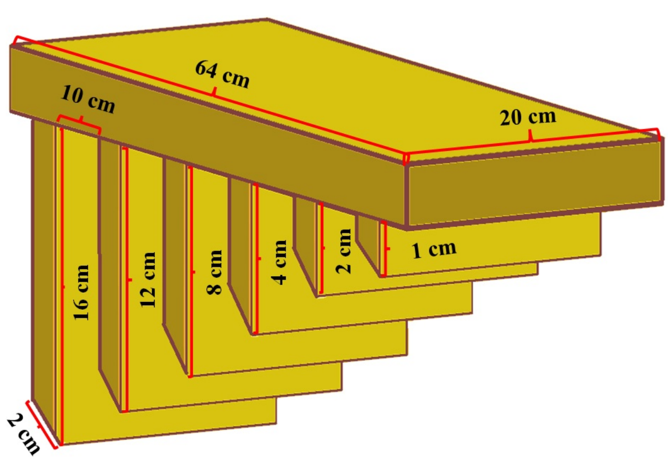



**Figure 2.** Schematic of the equipment for drilling into the ground at different depths.

Equation 1 established by Labouriau & Valadares (1976) was used to calculate emergence percentages.

$$\%E = \frac{(N \times 100)}{A} \quad (1)$$

where: %E - percentage of seedling emergence; N - total number of emerged seedlings; and, A - total number of seeds placed to germinate.

The emergence speed index (ESI) of the species studied were calculated using Equation 2 described by Maguire (1962).

$$ESI = \frac{E_1}{N_1} + \frac{E_2}{N_2} + \ldots + \frac{E_n}{N_n} \quad (2)$$

where: ESI - seedling emergence speed index; E1, E2, En - number of normal seedlings computed in the first, second and last counts, respectively; and, N1, N2, Nn - number of days from sowing to the first, second and last count, respectively.

The average emergency time (AET), synchrony (Z), and relative frequency of emergence (Fr) were obtained using Equations 3, 4, and 5 described by Santana & Ranal (2004).

$$AET = \frac{\sum Ni \times Ti}{\sum Ni} \quad (3)$$

where: AET - average emergency time; Ti - time between the start of the experiment and the i-th observation (day); and, Ni - number of seeds emerged on day i (not the cumulative number, but the number for the i-th observation).

$$Z = \left[-\sum Ni \times (Fr \times Log_2)\right] \times Fr \quad (4)$$

where: Z - synchrony; Fr - relative frequency of emergence; and, $Log_2$ - base 2 logarithm.

$$Fr = \frac{Ni}{\sum Ni} \quad (5)$$

where: Fr - relative frequency of emergence; and, Ni - number of seeds emerged on day i.

Variations in the relative emergence frequencies of *U. ruziziensis* seedlings were assessed by observing the unimodality or polymodality of the graphical polygons obtained as a function of the different depths of the seed in the soil over time.

The data on seedling emergence (%E), ESI, AET, and Z of seedlings were subjected to analysis of variance using the "F" test and the means of the treatments were compared using the Tukey test at 5% probability. If there was no interaction between the factors and/or significant contrasts for the specific seed weight factor, the data was adjusted to regression models using the Origin 8.5.1 SR1 program. The regression model was chosen based on the highest value of the coefficient of determination ($R^2$) at $p \leq 0.05$ according to the F test, respecting the biological response.

## Results and Discussion

It is noted that when evaluating the specific seed weight factor alone and its interaction with the *U. ruziziensis* sowing depth factor, no significant contrasts were found for the variables evaluated, regardless of the year in which the experiments were conducted. It should be noted that the sowing depth factor influenced the percentage of emergence, the emergence speed index, the average emergence time and the synchrony of emergence of the species seedlings in both years (Table 4).

*U. ruziziensis* seedlings emerged at up to 12 cm sowing depth, and no emergence was recorded at 16 cm, regardless of the year of study. In both years, the highest values of emergence of *U. ruziziensis* seedlings can be seen for seeds with low, medium and high specific weights that were placed between 1.0 and 4.0 cm deep, with values above 90% (Figure 3).

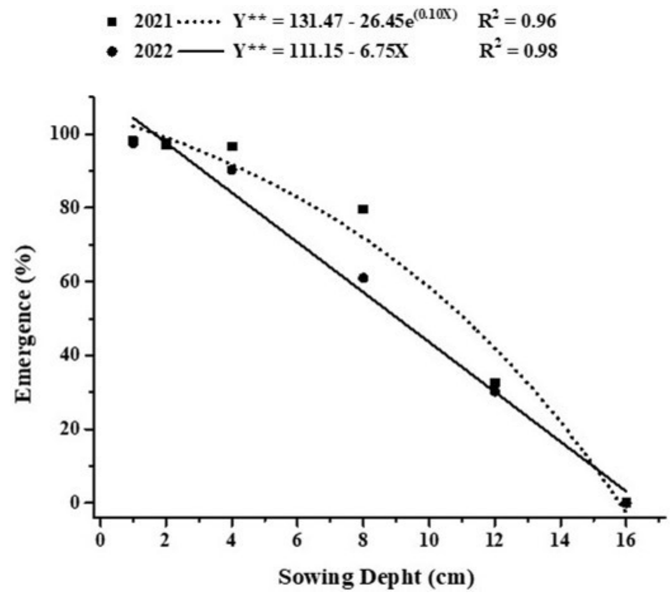
For the experiment conducted in 2021, there was exponential and downward behavior as the vertical distribution of seeds in the soil profile increased (Figure 3). When the crop was grown in 2022, a linear reduction was observed as the sowing depth changed (Figure 3).

As a result, it is important to note that the development of some weed species can be compromised by soil preparation processes that promote the incorporation of seeds at greater depths (Marques et al., 2019). This leads to an increase in the mechanical resistance imposed by the soil, as well as a reduction in temperature, $O_2$ availability and an increase

**Table 4.** Analysis of variance of the variables percentage seedling emergence in the field (%E), emergence speed index (IVE), average emergence time (AET), and emergence synchrony (Z) *U. ruziziensis* seedlings as a function of different specific seed weights, sown at different depths, in the years 2021 and 2022.

| Variation factor | Variables | | | |
|---|---|---|---|---|
| | %E | ESI | AET | Z |
| | 2021 | | | |
| $F_{SPECIFIC\ WEIGHT}$ (SW) | 1.77$^{ns}$ | 0.96$^{ns}$ | 0.85$^{ns}$ | 1.10$^{ns}$ |
| $F_{DEPTH}$ (D) | 298.72** | 228.77** | 512.01** | 88.24** |
| F (SW) × (D) | 0.64$^{ns}$ | 0.54$^{ns}$ | 0.84$^{ns}$ | 0.52$^{ns}$ |
| $F_{BLOCKS}$ | 1.23$^{ns}$ | 0.63$^{ns}$ | 0.67$^{ns}$ | 1.65$^{ns}$ |
| CV (%) | 12.28 | 15.11 | 7.96 | 23.59 |
| | 2022 | | | |
| $F_{SPECIFIC\ WEIGHT}$ (SW) | 1.52$^{ns}$ | 1.65$^{ns}$ | 3.25$^{ns}$ | 0.61$^{ns}$ |
| $F_{DEPTH}$ (D) | 462.40** | 441.10** | 800.66** | 61.97** |
| F (SW) × (D) | 1.41$^{ns}$ | 1.32$^{ns}$ | 1.30$^{ns}$ | 1.12$^{ns}$ |
| $F_{BLOCKS}$ | 1.54$^{ns}$ | 1.54$^{ns}$ | 0.81$^{ns}$ | 0.97$^{ns}$ |
| CV (%) | 10.38 | 12.93 | 7.43 | 25.17 |

* Significant at the 5% probability level; ** Significant at the 1% probability level; $^{ns}$ Not significant.




** Significant at 1% probability level.

**Figure 3.** Percentage emergence (%) of *Urochloa ruziziensis* seedlings after depositing seeds with different specific weights at different sowing depths, in the years 2021 and 2022.

in the accumulation of $CO_2$, forming fermented compounds during the respiratory process (Taiz & Zeiger, 2013), which can affect the germination process (Zuffo et al., 2014), which would explain the results found here *U. ruziziensis*.

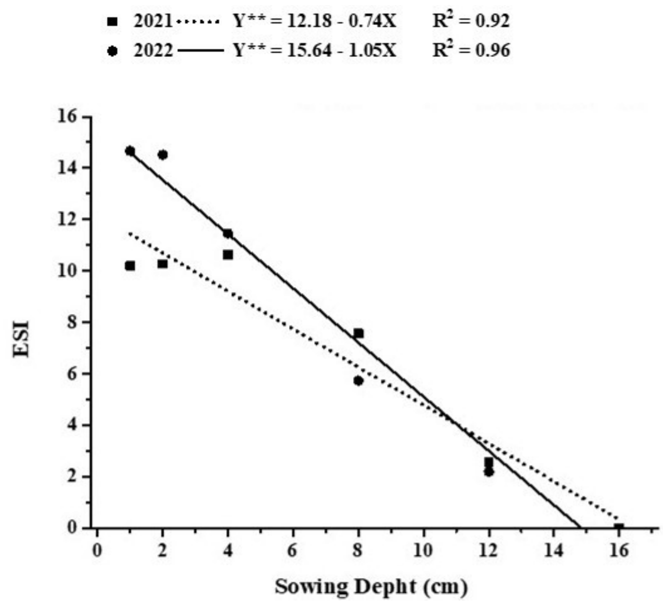
Marques et al. (2022) observed that the seedlings of *Urochloa decumbens* (Stapf) R. D. Webster (brachiaria grass) and *Cenchrus echinatus* L. (crabgrass) were able to emerge when sown between 0.5 and 12.0 cm deep. The researchers added that when sowings were made between 2.0 and 4.0 cm deep, there was an increase in the emergence of seedlings of both species. However, sowings at a depth of 12 cm led to significant reductions in the emergence of both species, corroborating the results found in this research for *U. ruziziensis*.

In both experiments, sowings between 1.0 and 4.0 cm deep provided the highest values for the emergence speed index of the species seedlings, demonstrating linear and descending behaviors (Figure 4).

However, for the experiment conducted in 2021, it was possible to see ESI values between 10.0 and 11.0, while in 2022 the results can be seen in a wider range (ESI between 10.0 and 15.0) when they were placed at shallow depths in the soil profile (1.0, 2.0 and 4.0 cm) (Figure 4).

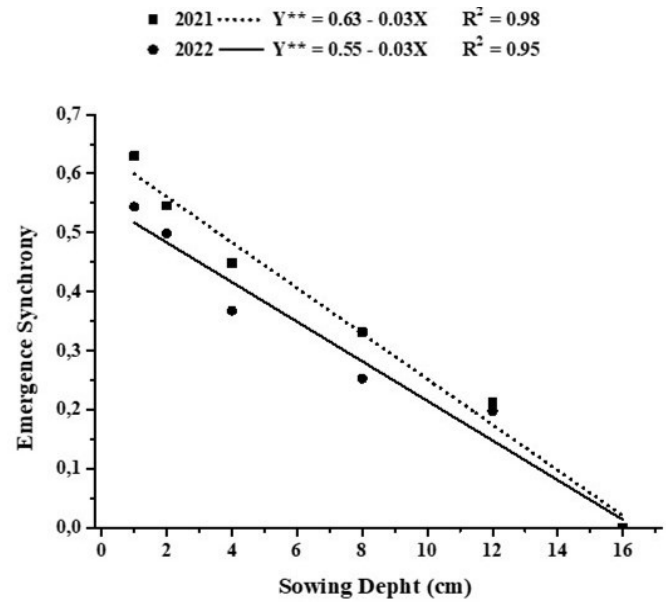
Sowing between 1.0 and 4.0 cm deep led to lower values and did not alter the average time for the emergence of *U. ruziziensis* seedlings, with values between 4.5 and 5.0 days and upward exponential behavior for the experiment conducted in 2021 and between 3.0 and 4.5 days with linear growth when evaluated in 2022 (Figure 5).

The synchrony of emergence of *U. ruziziensis* seedlings is inversely proportional to the increase in sowing depths, i.e., Z values gradually decreased with linear adjustments as



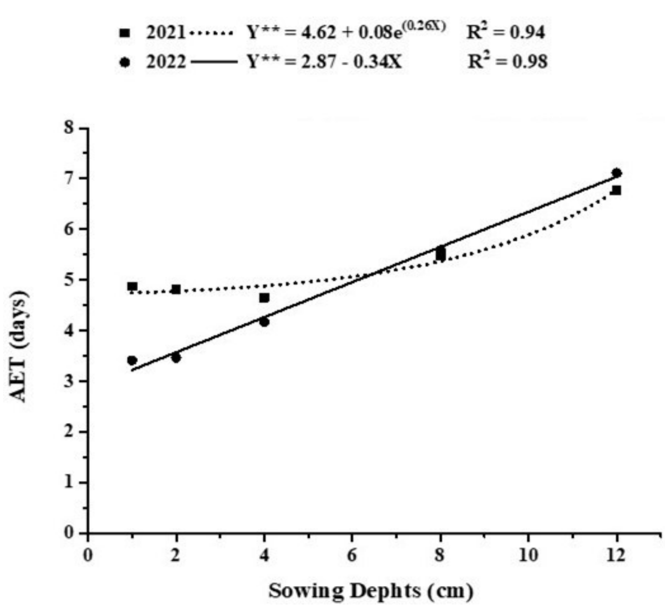

** Significant at 1% probability level.

**Figure 4.** Emergence speed index (ESI) of *Urochloa ruziziensis* seedlings after depositing seeds with different specific weights at different sowing depths, in the years 2021 and 2022.




** Significant at 1% probability level.

**Figure 6.** Emergence synchrony (Z) of *Urochloa ruziziensis* seedlings after depositing seeds with different specific weights at different sowing depths, in the years 2021 and 2022.




** Significant at 1% probability level.

**Figure 5.** Average emergence time (AET) of *Urochloa ruziziensis* seedlings after depositing seeds with different specific weights at different sowing depths, in the years 2021 and 2022.

the seeds were arranged at greater depths in the soil profile (Figure 6).

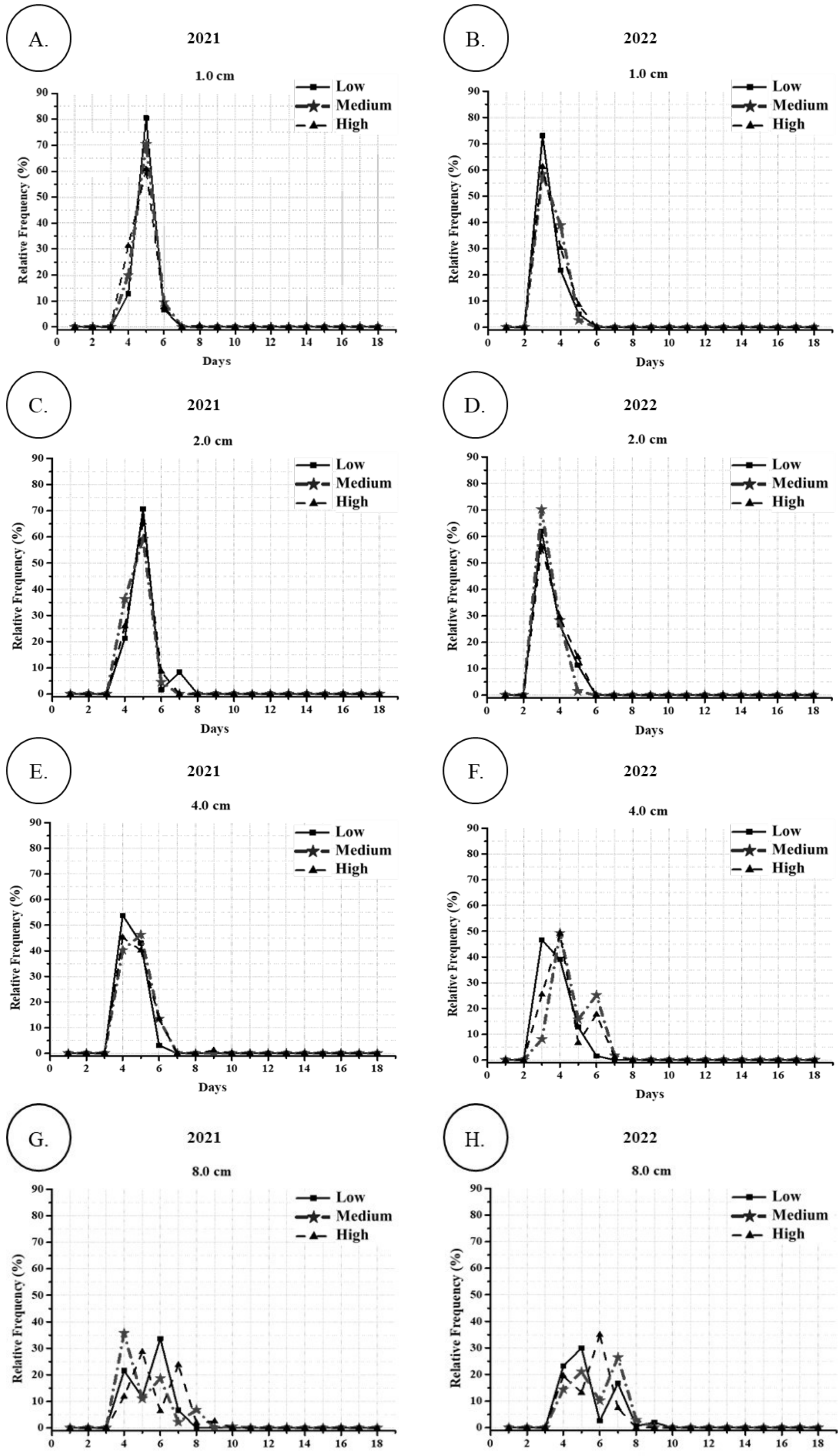
The germination flow of weed seeds, i.e., the synchrony of germination, is an important factor in characterizing the infestation patterns of a given species over time, and it is important to classify weeds in relation to their emergence pattern in order to aid control programs, especially integrated, in which chemical and mechanical methods are complemented, where both can have a general influence on the dynamics of weed emergence (Parreira et al., 2009).

When analyzing the relative frequency of emergence of U. ruziziensis seedlings, it can be seen that the greatest uniformity was obtained when the seeds with low, medium and high specific weight were placed at a depth of 1.0 cm in both years, at 2.0 cm when the experiment was conducted in 2022 and at 4.0 cm in 2021. It can be seen that the polygons of the relative frequency distribution of emergence for these depths tended towards unimodality, with emergence peaks between the second and seventh day after sowing (Figures 7A, 7B, 7D, and 7E).

When *U. ruziziensis* seeds were placed at 2.0 cm (low specific weight) in the experiment conducted in 2021; at 4.0 cm (medium and high specific weight) in 2022 and at 8.0 and 12.0 cm depth in both years and for all specific seed weights, there was polymodality in the relative emergence frequency polygons, characterized by two or more emergence peaks located mainly between the second and ninth day, indicating less homogeneity in the emergence behaviour of seeds with different specific weights (Figures 7C, 7F, 7G, 7H, 7I, and 7J).

Marques et al. (2023) report that soil temperature is one of the most important factors for seed germination, since temperatures near the soil surface are very similar, being significantly attenuated after 5 cm depth, which directly affects the seed soaking process.

This effect of temperature at different soil depths on the relative frequency of seed emergence is probably linked to the activation/inhibition of enzymatic processes linked to this phenomenon, mainly because temperature can act both as a factor in breaking dormancy and in controlling seed germination. It can be said that germination occurs

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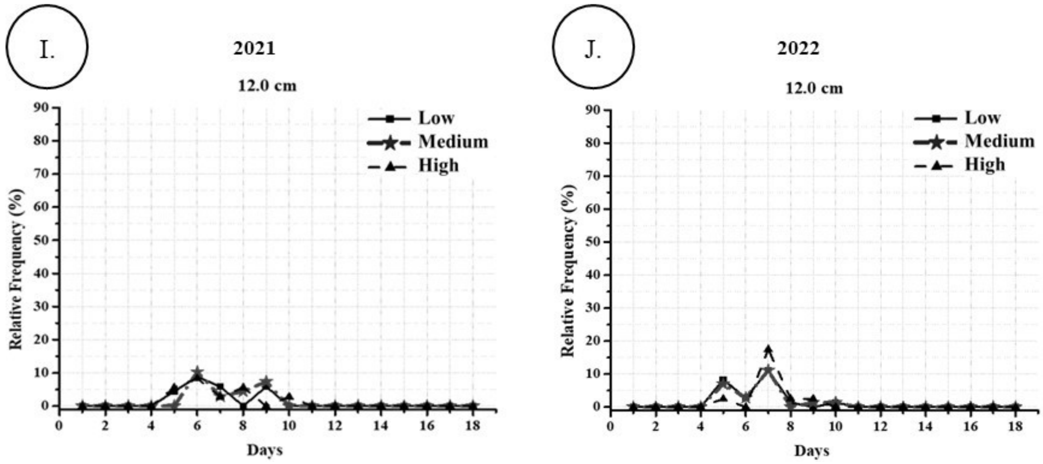


**Figure 7.** Relative frequency of emergence (Fr) of *Urochloa ruziziensis* seedlings after depositing seeds with different specific weights at different sowing depths (2021 = Figures A, C, E, G, and I - 1.0, 2.0, 4.0, 8.0, and 12.0 cm, respectively) and (2022 = Figures B, D, F, H, and J - 1.0, 2.0, 4.0, 8.0, and 12.0 cm, respectively).

within a certain limit, the amplitude and absolute values of which depend on each species. Within the temperature range in which the seeds of a species germinate, there is generally an optimum temperature, above and below which germinability is reduced, but not completely interrupted, causing numerous peaks in emergence (Costa et al., 2010).

Therefore, it is assumed that the intensity of proliferation of *U. ruziziensis* as a weed can be reduced by preparing the soil using mouldboard plows, for example, due to the deposition of seeds and plant remains at greater depths after mechanical operations (Rigon et al., 2020), directly interfering with the germination process of the species.

## Conclusions

The different specific weights of the seeds did not influence the emergence *Urochloa ruziziensis* seedlings in the field.

Seedlings of the weed *U. ruziziensis* emerged at depths of up to 12 cm. There was no seedling emergence when sown at 16 cm.

In general, sowings between 1.0 and 4.0 cm deep promoted the highest values for the percentage of seedlings emerging in the field and the speed of emergence index, and the lowest average time requirements for the emergence of *U. ruziziensis* seedlings.

The relative frequency distribution polygons show that *U. ruziziensis* seedlings have the greatest uniformity of emergence, regardless of the specific weight of the seeds, when placed at 1.0 and 2.0 cm deep. Depths greater than this lead to a staggering of the seedling emergence process in the field, which results in a delay in the propagation of the species.

## Compliance with Ethical Standards

**Author contributions:** Conceptualization: RFM, DM, SRM, CCM; Data curation: RFM, DM, SRM, CCM; Formal analysis: RFM, FRG; Funding acquisition: RFM; Supervision: RFM, DM, SRM, CCM; Writing - original draft: RFM, FRG; Writing - review and editing: RFM, FRG.

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## Literature Cited

Brasil. Ministério da Agricultura, Pecuária e Abastecimento. Regras para análise de sementes. Brasília: MAPA/ACS, 2009. 395 p. https://www.gov.br/agricultura/pt-br/assuntos/insumos-agropecuarios/arquivos-publicacoes-insumos/2946_regras_analise__sementes.pdf. 24 Sep. 2023.

Carvalho, N.M.; Nakagawa, J. Sementes: ciência, tecnologia e produção. 5.ed. Jaboticabal: FUNEP, 2012. 590 p.

Costa, F.P.; Martins, L.D.M.; Lopes, J.C. Frequência de germinação de sementes de crambe (*Crambe abyssinica* Hochst.) sob influência de tratamentos pré-germinativos e de temperaturas. Nucleus, v. 7, n. 2, p. 185-194, 2010. https://doi.org/10.3738/1982.2278.548.

Estação Agrometeorológica - UNESP. Dados. Jaboticabal 2021. https://www.fcav.unesp.br/#!/estacao. 06 Sep. 2023.

Grime, J.P. Plant strategies, vegetation processes, and ecosystem properties. 2 ed. New York: Wiley, 2006. 417p.

Instituto Nacional de Meteorologia - INMET. Dados metereológicos. Banco de dados metereológicos. Jaboticabal 2022. https://bdmep.inmet.gov.br/. 06 Sep. 2023.

Labouriau, L.G.; Valadares, M.B. On the germination of seeds of *Calotropis procera*. Anais da Academia Brasileira de Ciências, v. 48, n. 2, p. 174-186, 1976.

Lourenço, A.A.; Mota, R.V.; Sanches, J.L.; Marques, R.F.; Marchi, S.R. Weed interference in the establishment of *Urochloa ruziziensis*. Planta Daninha, v. 37, e019184957, 2019. https://doi.org/10.1590/S0100-83582019370100077.

Maguire, J.D. Speed of germination—Aid in selection and evaluation for seedling emergence and vigor. Crop Science, v. 2, n. 2, p. 176-177, 1962. https://doi.org/10.2135/cropsci1962.0011183X000200020033x.

Marchi, S.R.; Marques, R.F.; Souza, R.M.; Justo, C.F.; Martins, C.C. Straw interference in the emergence of talquezal seeds from different origins. Planta Daninha, v. 38, e020223128, 2020. https://doi.org/10.1590/S0100-83582020380100059.

Marques, A.S.; Marchi, S.R.; Pinheiro, G.H.R.; Marques, R.F.; Martins, C.C. Emergence of razor grass on the basis of origin and seed depth in the soil profile. Planta Daninha, v. 37, e019214034, 2019. https://doi.org/10.1590/S0100-83582019370100126.

Marques, R.F.; Souza, G.S.F.; Martins, C.C.; Marchi, S.R.; Martins, D. Emergence and development of weeds according to the sowing depth and light intensity. Revista Caatinga, v. 36, n. 3, p. 502-512, 2023. https://doi.org/10.1590/1983-21252023v36n303rc.

Marques, R.F.; Souza, G.S.F.; Pereira, M.R.R.; Marchi, S.R.; Martins, D. Sowing depth and light intensity in the emergence and development of monocotyledonous weeds. Bioscience Journal, v. 38, e38083, 2022. https://doi.org/10.14393/BJ-v38n0a2022-60820.

Melo, L.F.D.; Martins, C.C.; Silva, G.Z.; Sanches, M.F.G. Processing in the quality of tanzania grass seeds. Engenharia Agrícola, v. 36, n. 6, p. 1157-1166, 2016. https://doi.org/10.1590/1809-4430-Eng.Agric.v36n6p1157-1166/2016.

Monquero, P.A.; Orzari, I.; Silva, P.V.; Penha, A.S. Interference of weeds on seedlings of four neotropical tree species. Acta Scientiarum. Agronomy, v. 37, n. 2, p. 219-232, 2015. https://doi.org/10.4025/actasciagron.v37i2.19280.

Orzari, I.; Monquero, P.A.; Reis, F.C.; Sabbag, R.S.; Hirata, A.C.S. Germinação de espécies da família Convolvulaceae sob diferentes condições de luz, temperatura e profundidade de semeadura. Planta Daninha, v. 31, n. 1, p. 53-61, 2013. https://doi.org/10.1590/S0100-83582013000100006.

Parreira, M.C.; Pavani, M.C.M.D.; Alves, P.L.C.A. Fluxo de emergência de *Ipomoea nil*, (L.) Roth., *Ipomoea quamoclit* (L.), *Merremia cissoides* (Lam.) Hall, f. Nucleus, v. 6, n. 2, p. 83-98, 2009. https://doi.org/10.3738/1982.2278.194.

Rigon, E.; Amado, T.J.C.; Pott, L.P.; Ulguim, A.R.; Buhse, A.K. Densidade de plantas daninhas sob intervenções em três distintas zonas de manejos. Agrarian, v. 13, n. 49, p. 405-418, 2020. https://doi.org/10.30612/agrarian.v13i49.10600.

Santana, D.G.; Ranal, M.A. Análise da germinação: um enfoque estatístico. 1.ed. Brasília: Editora UnB, 2004. 248 p.

Santos, T.A.; Resende, A.S.; Silva, F.F.; Moraes, L.F.D.; Chaer, G.M. Growth of tree species in coexistence with palisade grass *Urochloa brizantha* (Hochst. ex A. Rich.) Stapf cv. Marandu. Planta Daninha, v. 37, e019178812, 2019. https://doi.org/10.1590/S0100-83582019370100113.

Silva Junior, A.C.; Marques, R.F.; Gonçalves, C.G.; Pereira, M.R.R.; Martins, D. Effect of glyphosate in Johnsongrass submitted to different soil water potentials. Journal of Environmental Science and Health. Part B: Pesticides, Food Contaminants, and Agricultural Wastes, v. 58, n. 4, p. 1-9, 2023. https://doi.org/10.1080/03601234.2023.2176671.

Souza, G.S.F.; Marques, R.F.; Pereira, M.R.R.; Marchi, S.R.; Martins, D. Light intensity and sowing depth on the emergence and development of weeds. Advances in Weed Science, v. 39, e02100043, 2021. https://doi.org/10.51694/AdvWeedSci/2021;39:00016.

Taiz, L.; Zeiger, E. Fisiologia vegetal. 5.ed. Porto Alegre: Artmed, 2013. 918 p.

Zuffo, A.M.; Andrade, F.R.; Silva, L.M.A.; Menezes, K.O.; Silva, R.L.; Piauilino, A.C. Profundidade de semeadura e superação de dormência no crescimento inicial de sementes de *Brachiaria dictyoneura* (Fig. & De Not.) Stapf (1919) cv. Llanero. Revista Ceres, v. 61, n. 6, p. 948-955, 2014. https://doi.org/10.1590/0034-737X20146106009.